

burnt would be 1·6 lb. per indicated horse-power with one ship, whilst the sister vessel would be "gassing" (we shall have to become reconciled to the objectionable term) with a consumption of 1 lb. of coal per indicated horse-power per hour. Here is a saving of more than 50 per cent. in weight of coal carried, bunker space, time of coaling, and other subsidiary matters, amongst them money cost. At lower powers the figures bear approximately the same ratio.

These are enormous strategical advantages, but the tactical benefits offered are hardly less pronounced. By means of profile views the author showed the gun emplacements of the two ships. With the usual two-chimney arrangement of the steam ship, there are four 12-inch guns placed in pairs in two barbettes at the ends of the battery, as is usual. These have arcs of training, a few degrees before or abaft the beam respectively, whilst the weapons of a lighter nature can only fire on their respective broadsides. When we turn to the ship without boilers—the gas-engine ship—we find the space that would be taken in the other vessel by funnels, uptakes, &c., occupied by three additional barbettes placed *en échelon*, and each containing two 12-inch guns. There are also the two end barbettes with their four guns, as in the steam ship. These six centrally placed guns can be, moreover, trained on either broadside, so that, in an encounter between the steam ship and the gas ship the latter could bring ten 12-inch guns into action as against four of the former vessel, supposing the encounter to be broadside on; or, to put the case another way, the gas ship could fight a steam ship on each broadside, and have a superiority over her enemies of two 12-inch guns. With secondary armament the problem is more complicated, and could hardly be explained without diagrams.

What, it will be asked, are the defects of these qualities? and an answer can only be given by the light of experience—an experience only likely to be gathered by steps. The marine steam engine has been brought to such a state of efficiency that its performance can be practically depended upon; this is not the case with the producer gas engine. There are many things to find out yet, the problem being more complex from the combination of mechanical and chemical sciences that have to be applied. With gas engines afloat—a very different thing from gas engines ashore supplied from a central source—one hears of the explosive mixture failing, from unexplained causes, and the engines stopping without warning, and there are details of working connected with ignition and other points which have yet to be perfected. For much the same reason that many naval engineers prefer hydraulics to electricity for working armaments, steam is likely to be preferred to gas for propelling battleships. Which will ultimately survive time will show; in the meantime, it may be said Mr. McKechnie has worked out a very strong case for gas.

The remaining paper taken on this day was by Mr. Simon Lake, who dealt with the subject of submarine boats. The type of vessel the author advocates is fairly well known, its most striking characteristic being that it is fitted with wheels so that it can travel along the bottom of the sea. The paper gave an interesting account of some of Mr. Lake's adventures in his ingeniously devised craft.

On the second day of the meeting Mr. W. J. Luke, of Clydebank, read a paper in which details of certain points in the construction of the new big Cunard ship *Lusitania* were set forth. The chief point was the application of high tensile steel in the upper part of the hull structure, a detail of shipbuilding design which possesses definite advantages, seeing that the hogging stresses are more serious than the sagging stresses, and therefore tension is of high importance for the upper member of the girder formed by the hull structure. The evolution of the modern cargo steamer was the subject of a paper by Mr. S. J. P. Thearle, of Lloyd's. It was a contribution that will be of value in the Transactions of the institution for future students of the history of shipbuilding. Cranes for shipbuilding afforded a subject of practical interest for Signor C. Piaggio.

The two papers that were read at the evening meeting of the same day were both of interest and importance.

They described two forms of instrument for measuring the power given off by turbines. The author of the first paper was Mr. A. Denny, and of the second Mr. J. H. Gibson. As is well known, the ordinary steam-engine indicator, by which horse-power has been measured since the days of James Watt, is useless for application to turbines, because there is no reciprocating motion with the latter. This has been a serious obstacle in the path of ship designers, but it appears to have been overcome by taking indicators of the torsion of the shafting through which power is conveyed from the turbine to the propeller. In both the instruments described by the authors of the two papers recourse is had to this means, but the method of recording is different. In the Denny and Johnstone torsionmeter is an electrical method in which a telephone is used, whilst in Mr. Gibson's instrument recourse is had to a flash of light deflected by a mirror. The details by which these processes are made practical have been worked out in each case with great ingenuity, but it would be difficult to make them clear without illustrations. It may be pointed out, as Lord Glasgow stated at the meeting, that the successful application of these instruments will solve a problem that the elder Froude worked out with much enthusiasm during the later years of his life, though with very partial success. A paper on propeller struts, by Mr. G. Simpson, was of purely professional interest.

One of the most interesting papers of the meeting was Sir William White's contribution on experiments with Dr. Schlick's gyroscopic steadyng apparatus. This paper is of such interest that we propose to deal with it separately. Its full comprehension, however, involves a knowledge of the principles set forth in a paper read by Dr. Schlick a few years ago, Sir William having thought it unnecessary to go over the same ground again.

The other papers read were on the approximate formulæ for determining the resistance of ships, by A. W. Johns; on the application of the integrator to ship calculations, by J. G. Johnstone; on the prevention of fire at sea, by Prof. Vivian B. Lewes; on modern floating docks, by Lyonel Clark; and on some phases of the fuel question, by Prof. Vivian B. Lewes.

The institution will hold a summer meeting in Bordeaux towards the end of June.

TICKS AS TRANSMITTERS OF DISEASE.¹

MANY statements are found in medical works as to the local poisonous effects of tick bites, but these are of small importance compared with the diseases inoculated by ticks. Until a year or so ago ticks were only known to transmit one kind of disease, and this was confined to the lower animals. Of these diseases, "Texas" fever in cattle may be regarded as the type. These diseases, which are met with in cattle, horses, asses, sheep, and dogs, are due to parasites which attack the red cells of the blood. The parasites are characterised by their pear shape, and hence were originally called Pyrosoma; but this name has now generally been replaced by *Piroplasma*, and the infection by these parasites is known as piroplasmosis.

Smith and Kilborne in America, by their classical researches, first established the fact that Texas fever in cattle was transmitted by ticks. We may consider the mode of transmission somewhat more closely. Ticks in their life-history go through the stages of eggs, larva, nymph, and adult. In the case of transmission of malaria by certain Anophelines, we know that the adult mosquito when it has fed on the blood of a malarial patient can transmit the disease again after the lapse of ten days, more or less, to a healthy person. Very different, however, is the mode of transmission of piroplasmosis by ticks. Smith and Kilborne showed that Texas fever was transmitted from the sick to the healthy animal, not by adult ticks, but that it was young ticks hatched from the eggs

¹ "Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India." New series, No. 23.

"The Anatomy and Histology of Ticks." By Capt. S. R. Christophers. Pp. 55+plates. (Calcutta: Office of the Superintendent of Government Printing, 1906.) Price 4s. 6d.

Memoir xxi. of the Liverpool School of Tropical Medicine, September, 1906. Pp. xiv+118+plates. (London: Williams and Norgate.) Price 7s. 6d. net.

of ticks found on diseased animals that transmitted the infection. The transmission is thus hereditary, and of a transmission of this kind we have no evidence at all in the case of malaria, though it has been stated that this mode of transmission occurs in yellow fever.

The transmission of Piroplasma by ticks is thus peculiar, and when we come to examine the known facts closely the peculiarity increases. Smith and Kilborne, as we have stated, showed that the infection of Texas fever due to *P. bigeminum* was carried by ticks in their larval stage. In the case of *P. canis* producing malignant jaundice in dogs the mode is different. In this case it is not the larva, but the adult tick of the second generation that transmits the disease. This also is the case for red-water of sheep due to *P. ovis*. In the case of piroplasmosis of the horse, the mode has not yet been definitely established. Finally, in the case of "African coast fever" in cattle, a disease resembling in some respects "Texas" fever, but due to a different Piroplasma, viz. *P. parvum*, we appear to have a still more complex state of things. The transmission, according to Lounsbury, in the case of the tick (*R. appendiculatus*) is not hereditary, but is transmitted by nymphs which in the larval stage have fed on infected animals, and also by adults which in the nymphal stage have fed on infected animals. Hence it is clear that analogy as a guide is almost useless, and it must be determined by actual experiment how in each case the transmission is brought about. Of the actual changes undergone by the Piroplasma in the tick, egg, larva, nymph, as the case may be, we know but little.

Recently, however, Koch described peculiar forms in the stomach of the tick which he considers to represent a cycle of development. Other forms have also been found in the egg, but not, so far, in the larva or nymph. No doubt research will be in the future directed to these points.

Piroplasmosis is, then, an important set of diseases transmitted by ticks, but, further, they have been recently shown to play a part in the transmission of those minute, slender, corkscrew-like parasites known as Spirochætes. These parasites give rise in man to a dangerous and often fatal fever, a marked character of which is the tendency to relapse. Hence it is known as recurrent or relapsing fever. The cause of relapsing fever has been long known to be a Spirochæte, viz. *S. obermeieri*, but it is only recently that the nature of "African tick fever" has been elucidated. This is also due to a Spirochæte, and as it is different from the former it has been named *S. duttoni*, after the late Dr. Dutton, who with Todd was the first to elucidate the mode of transmission of the disease. The memoir of the Liverpool School of Tropical Medicine contains an elaborate study, clinical and experimental, of the characters of this Spirochæte. Perhaps the most convincing proof brought that these two Spirochætes are different lies in the fact that an animal that has recovered from an attack of the one is still susceptible to inoculation with the other, and *vice versa*. How the ordinary relapsing fever is transmitted is still uncertain; it may be by bugs, though the numerous experiments recorded in this memoir to transmit *S. duttoni* in this way have all failed; but ticks are the transmitters of *S. duttoni*, and in Africa the particular tick implicated is *Ornithodoros moubata* (Murray). This tick, long of evil reputation, can transmit the disease in the following ways:—(1) directly, i.e. by means of adults that have sucked the blood of infected patients; and (2) by the nymphal descendants of these adults. Spirochætes have also been found by Koch in the eggs of ticks, but whether or no they undergo any development is at present unknown.

From what we have said it will be evident that to the medical man a knowledge of ticks is of the utmost importance, and every medical man will welcome this memoir of Captain Christophers on the anatomy and histology of ticks. The histological portion will be especially useful, as the systematic treatises, e.g. Neumann's memoirs, deal solely with the external characters on which their classification is founded. The internal anatomy of ticks has until quite recently been described in a very meagre fashion, and it is evident that such a knowledge is absolutely necessary in the search for developmental forms of Piroplasma and Spirochæta in the various tissues.

Those who are acquainted with Captain Christophers's

previous work on the anatomy and histology of the mosquito will know what to expect in this memoir.

The clear descriptions, illustrated by numerous diagrams and six photogravure plates, might with advantage be imitated by other recent writers on the same subject.

With regard to the plates, unfortunately in passing through the press the lettering of many of the figures has not appeared. We may note also that the secretion from the coxal glands was observed by Dutton and Todd in the Congo.

The Liverpool memoir, besides the study of *S. duttoni*, contains a description of various attempts made to cultivate this Spirochæte, but all in vain. A new Spirochæte in the mouse, *S. laverani*, is also described. Two papers on Trypanosomes, and a number of pictures of the research laboratories at Runcorn of the Liverpool Tropical School, complete a very interesting memoir.

J. W. W. STEPHENS.

TROPICAL BOTANY.

A N interesting number of the Annals of the Royal Botanic Gardens, Peradeniya (London: Dulau and Co.), has just appeared. In the first paper Mr. R. H. Lock gives the third instalment of his work on plant-breeding in the tropics, dealing with maize. Unlike some Mendelian experiments, the results have been obtained with large numbers, and on a total, for instance, of 111,697 seeds, the result was 50·17 against an expectation of 50·11. The second paper is by Mr. T. Petch, on the fungi of the nests of the common termites, or white ants, of Ceylon, a worthy successor of Möller's classical paper on the fungi of the leaf-cutting ants of South America. He has worked out in detail the entire life-histories of the fungi, and shows that while the "regular" fungus is a Volvaria (already described elsewhere, as are so many of the tropical fungi that have only been worked at in Europe, under at least six genera), the garden also contains "weeds," one of which, at least, a Xylaria, is impossible of eradication by the ants. Incidentally, grave doubt is thrown on Möller's theory of selection of the fungus by the ants, for the "Kohl-rabi heads" occur in the termite nests in an even more perfect and complex form than in the leaf-cutters' nests, and yet the same form appears on an allied outside fungus not cultivated by the ants. The paper is well illustrated.

The third paper is by Dr. Willis, on the flora of Ritigala. This is an isolated mountain in the "dry" zone of Ceylon, forty miles from any other, and high enough to condense much moisture on the top, where are found 103 species not otherwise known in the dry zone. These, being species of the lower zone of the southern mountains, must have leapt the whole forty miles in one operation. Among them are twenty-four bird-carried things, with one very slightly marked endemic variety among them; forty-nine wind-carried things (including twenty-four ferns), with two endemic species and one variety; and thirty plants the mode of distribution of which may be called doubtful or accidental. Six of these are low-country plants which might come by easy stages, and of the remaining twenty-four no less than nine are endemic to Ceylon and to the couple of acres of the summit of Ritigala. One of these nine has been found in South India, but the other eight are confined to Ritigala. This goes to show, therefore, that endemism goes with difficulty of distribution and rare arrival in one spot.

The final paper is by Mr. A. M. Smith, who has followed up Blackman's already almost classical paper on optima and limiting factors by a careful study of growth under different conditions in Ceylon—where it is rapid, and can be easily measured—and finds that Blackman's theory explains matters well. In *Dendrocalamus* (giant bamboo) at Peradeniya the limiting factor is humidity, while at night at Hakgala, where it is cold, the temperature is limiting and humidity has no effect. This work explains, but renders practically valueless, the enormous mass of observations on growth made by physiologists from Sachs onwards, and no one interested in physiology can afford to leave this paper unread. It also helps to show what an opening there is for really good physiological work in the tropics. The whole number is one of considerable interest and importance, and cannot be neglected by botanists.